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A VERSATILE, USER-ORIENTED, COMPUTERIZED LIBRARY SYSTEM

By

ERIC NEURON
Operations Research Division

7 November 1966

NAVAL MISSILE CENTER

Point Mugu, California

NAVAL MISSILE CENTER

AN ACTIVITY OF THE NAVAL AIR SYSTEMS COMMAND

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Commander

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Dr. W. M. Simpson, Head, Operations Research Division; and Mr. W. L. MacDonald, Acting Head, Weapons Program Management Department, have reviewed this report for publication.

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SUMMARY

The problem of obtaining intelligence (i.e., information) in a timely fashion is only exceeded by the problem of how to reference, or store, that portion of the information which is of lasting interest or use. The referencing or storing methods must be designed to allow almost instantaneous retrieval of the key data leading to the desired information or the recovery of the information directly. A secondary, but frequently desirable, feature is the ability to determine quickly the kinds of information available as well as the quantity of items of each kind.

A computer-aided system has been devised which appears to be able to satisfy such referencing and storing needs for an organization of roughly 5 to 50 specialists. This report is intended to introduce the reader to the system and serve as a guide in the efficient use of its potentialities.

INTRODUCTION

The reference material accumulated by scientific groups has assumed formidable proportions and will, of course, grow larger as time goes on. The problem is aggravated by the large proportion of classified material required as ready reference. The listing and maintaining of the available information alone represents a continuous and time-consuming task which requires the active cooperation of all members of the working group. Unless appropriate mechanisms are instituted early in the information listing and maintenance process, the problem of finding applicable information in the large mass of nonapplicable material becomes rapidly unmanageable.

The system described is based on some fundamentally different notions than most other library systems. There is, for instance, no implicit assumption that the mass of information which must be referenced, and retrieved when necessary, will remain of manageable size. The system relies on a 1401 computer and is only limited by the computer capabilities which are, in general, expandable in time. There are no restrictions as to the type of material which can be referenced. Information listing turns out to be a cooperative venture. Methodologically, the listing of anything which must be subsequently retrievable depends upon the terms in which the person desiring the listing tends to think of the matter. The listing effort itself can be handled by persons specializing in this work, but the terms can be supplied only by the person requesting the listing. The methods and routines of this system have been designed with these features in mind.

SYSTEM DEVELOPMENT

During the early development of this system, one of the needs felt to be urgent was incorporation into the system of all data needed for standard bibliographic work. The need appears less urgent at this time but, within the limitations imposed by the computer retrieval operations, all the data required for source listing in standard Navy format are available in the prototype library system of the Operations Research Division. The dominant problem at this time is the retrieval, at relatively high speed, of information known to be contained in the material available in the files or on call from some outside source. This implies that information once brought to the cognizance of the members of the organization must be somehow listed or cataloged in a fashion which will make the material available to most of these members without excessive search or difficulties of interpretation and linguistic barriers.

The prevalent habit of "splintering" the English language for the purposes of the "in group" of microspecialized sets of engineers and scientists has caused considerable hardship to librarians and programmers attempting to create similar retrieval systems. Therefore, in the development of the system discussed here, this problem was approached with some initial trepidation. It was soon realized, fortunately, that communications within a small group of

scientists, no matter how diverse their backgrounds, depended upon the development of an interspecialty understanding for efficient working relations. Thus it became possible to postulate a common language for the small organization and hence the possibility of forming a system of subject indicators which would suffice to describe areas of interest for the members of the group.

To prescribe a standard set of indicators into which material to be referenced and retrieved had to be "shoehorned" appeared to have all the disadvantages of the usual library referencing systems without the excuse that the system had to be "general," "uniform," and "permanent." The futility of an attempt to straitjacket a language in the face of a rapidly changing technology was obvious. The logical alternative was to treat the creation of a set of usable indicators as a subset of a living language creation process, with similar freedoms and flexibility.

This implied that an organization formed from a group of people of dissimilar background and assembled for a common purpose should be allowed to produce a set of indicators naturally, in the course of their normal work. It further implied that such a structure, if culled in a continuous process, would tend to reflect the language and speech habits peculiar to the organization and would change, with a time lag, along with them.

incidentally, this is basically the same method as that used by the Defense Documentation Center (DDC), with the exception that their system, presumably for internal convenience, has a numerical call number for 22 major subject fields and a secondary number for the major groups within the field. DDC material within groups is then arranged by descriptive words which largely summarize the title information. For a small organization, with its relatively much smaller number of listings, the labor and computer complexity required by a dual system of combined numerical and plain language indicators appeared to be excessively costly.

There are further similarities between the DDC indexes and the system described herein. Both use indexes ordered by author, subject, and report or accession number. The readout of the described system is considered better in the subject-ordered indexing because it provides an automatic cross-referencing for every indicator used in the description of an individual piece of material. The chief difference between the two systems appears to be the unconscious emphasis placed by DDC on the facility with which the librarian can locate material, while the subject system is designed for the user to find out what is available to him.

SYSTEM PARAMETERS

The various parameters which are tape-stored by the computer to provide the library system services can be learned best by looking over the log form shown as figure 1. Certain of these parameters are very important, and the

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LIBRARY LOG

C = CARD CODE, A = ACTION CODE, X = CLASSIFICATION CODE, U = USER CODE.
ACTION CODES . . . . I = INSERT, M = MODIFY, D = DELETE.
CLASSIFICATION CODE. . . .U = UNCLASSIFIED, P = PERSONS, D = INTERNAL USE,
C = CONFIDENTIAL, S = SECRET, T = TOP SECRET,
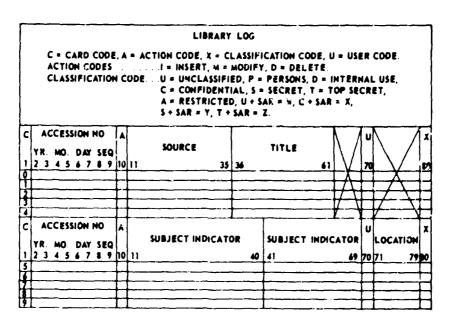A = RESTRICTED, U + SAR = W, C + SAR = X,
S + SAR = Y, T + SAR = Z.

Figure 1. Sample Library Log Form.

computer program has been instructed to refuse to handle information which
contains apparent errors in these parameters and indicate what it found objec-
tionable in them. In the following paragraphs, these critical parameters will
be discussed first, followed by the other parameters which may be used when
needed.

The important parameters, which the user must be careful to insert cor-
rectly, are three codes and the accession number. The fourth code, the card
code, shown in figure 1, is normally taken care of by the key-punch operator.

The action code provides for the insertion of information into the data
bank, the correction of errors found in data already stored in the bank, and
the removal of superfluous material from the bank. Detailed instructions on
how to do this will be contained in subsequent sections. Here, it seems suf-
ficient to point out that the use of the action codes must be consistent through-
out a given accession number. Hence, if the user desires to insert a piece
of information, every card of this information set must show an "I" in column
10. A single IBM card, or more as necessary, can be used to modify a portion
of already stored information by using the proper card code, accession number,
and an "M" in column 10. Deletion of an item can be accomplished with a
single instruction.

The classification code appearing in column 80 must appear in any informa-
tion to be inserted and any modification or deletion action. An "approved" code
letter must be on every IBM card used for these purposes, and a set of cards
all belonging to the same piece of material must have one, and only one, classi-
fication code. It is the user's responsibility to classify the material to be
stored at the proper security level; the computer program merely assures that
data which belong together, according to the user's request, are all classified

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uniformly so that a complete printout can be performed without any difficulty. Note that the designation "SAR" in figure 1 is derived from the term "Special Access Required."

The system is programmed in a fashion which assures rejection of non-uniformly classified material previous to storage and which guards against the printout of information on paper which indicates a lower, or higher, classification than that required by the material. The tapes which store the information used in the library system data bank are classified in accordance with the highest classification carried by any of the material contained therein and stored accordingly.

The user code in column 70 assures that material to be stored in one library system is indeed stored in this system and no other. In this manner, the same basic computer program can be used for any number of individual library systems, with an assurance that chances for false insertions or retrievals of data are almost zero. Moreover, since classified readouts of any of the library systems must be signed for by authorized personnel, the user code prevents accidental breach of security regulations, such as providing the user of one classified library system with data from another one.

The accession number is unique for any specific material. It is created from the known time of origin of the material, and the sequence of material of the same temporal origin, as it becomes known to members of the user's organization. In listing the material, one therefore takes the best estimate of the date of publication of the material and puts it in columns 2 through 7; then one finds out how many other items are already listed for this date and enters the next higher number in columns 8 and 9.

The title space hardly needs extensive discussion. Note that this program does not produce a listing of the stored material by title, and neither does the DDC index. The reason for this is simple enough--few of the titles of ordinary books or articles are written to permit a significant ordering in this fashion.

The 125 spaces (maximum) available for source descriptions are used for the same purpose that the "Corporate Author-Monitoring Agency" space of the DDC index is used for. This permits the listing of material in accordance with sources (such as RAND, NASA, etc.) in a computer-ordered readout called "source list." The names of human authors are entered as subject indicators, which permits retrieval by author's name as well as by words descriptive of the material's content.

The spaces provided for the listing of subject indicators originate the bulk of the material which makes the library system useful. As has already been indicated, a subject indicator is a word description of all or part of a piece of material to be referenced or stored. The computer readout, by alphabetically ordered subject indicators, forms a cross-reference file which can be used in a number of ways. If the number of stored items is relatively small, a

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manual search of the computer readout by subject indicators which are applicable would generally suffice for quick location of computer-listed information sources in the area of interest. If the library contains a great amount of related material, the use of the retrieval system would probably lead to quicker and better results. To aid the user of the library, all subject indicators used in the system are listed alphabetically in the Authority File. The number of times a specific subject indicator has been used for material entered in the system will also be noted in this file. The user of the system will, therefore, find the authority file of considerable help in the entering of new material as well as for retrieval operations, and can avoid spelling errors and minor discrepancies which would unnecessarily escalate the number of subject indicators listed.

SYSTEM INPUT PREPARATION

This section provides instructions which should enable anyone to write information input forms for the computerized library. The instructions are designed to be particularly useful to the single person designated, within the organization, to handle contacts with the computer operations personnel. The other members of the organization who will use the system should have a general knowledge of the preparation methods, but may restrict their detailed studies to the methods of using the title, source, subject indicator, and classification code spaces.

Card Code

The card code is predetermined and is used only by the personnel punching the cards for machine operation. If the system user employs the spaces in a normal manner, he need not worry about the proper coding of the information he is inserting.

Accession Numbers

The assignment of the accession numbers can, and should, be a cooperative duty of the system user and the individual assigned to the major coordinating duties (let us call him the central control clerk). The user can fill out the first three two-digit groups as follows:

1.   The first group represents the last two digits of the year.

2.   The second group refers to the month (01, 02, etc.).

3.   The third group designates the numeric day of the month.

The fourth (and last) two-digit group should be left open by the system user to permit the central control clerk to use the space for its intended purpose as a measure preventing duplication in listings and in filing.

The unusual arrangement of the accession number calling for the listing of the year ahead of the month and the day of the month is based on empirical evidence of the availability of document issue date information. It is frequently much easier to find the year in which some information was published than any estimate of either the month or day of its formal issue. The material which has been listed in the library can, if desired, be filed in order of accession number. This produces an automatic grouping of the material by age and facilities compliance with the standard housekeeping practice of removing "over-age" material from the files.

The accession numbers are shown in all listings except the authority file. The program provides a readout of all library holdings by ascending accession number.

Source Space

The source space, columns 11 through 35 on cards 0 through 4 of a listing, is used to name the publisher of a book or magazine, the name of the magazine containing the listed material, the organization which has published the paper or speech of one of its members, or the organization for which a listed expert works, etc. Listing in this space is performed as if the card divisions were of no consequence. The computer writeout will provide a spacing which differs from the card spacing. Attempts to follow the computer spacing usually make the listing chore so onerous that it is easier to live, sometimes, with less-than-perfect readouts than to try to "pretty things up."

Note that this space must be used to provide the information needed in standard references. Hence, in the listing of an article or some similar information, completeness is extremely important. Such items as page numbers, edition number, etc., are easy to forget and exasperating to search for a year later.

The space should also be used for information which can help in the obtaining of material or information. For instance, addresses and telephone numbers can be listed here if their future importance seems to warrant.

Title Space

Titles are listed in full when within space limitations. The method of filling the space is similar to that noted for the source space. The card divisions may be disregarded.

Action Codes

Three different symbols are available for insertion in column 10 of the log cards. One of these symbols must appear in each log card to be inserted

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in the computer program. Absence of a code, or the presence of contradictory codes in cards belonging to the same information card set, will cause the computer to reject the whole card set in which the error occurred. The three symbols are used to insert, modify, or delete material in the program. The methods to be used to accomplish these operations will be described in turn.

Insertion Rules

Only complete information items should be inserted. Additions or changes to existing library entries are handled by the system described below under Modification Rules. Inserts must have an "I" placed in column 10 of every card used and the user code inserted in column 70 of every card. The classification code (to be explained later) must appear in column 80 of every card used.

Modification Rules

Only existing library entries can be modified. Any one or more cards in the library computer file can be modified by the use of the symbol "M" in column 10 and the appropriate user code in column 70 of the replacement card(s). (If an entry is to be rewritten almost completely, the deletion of the old item and insertion of the new might be simpler.) To use the modification system, the item to be modified is oriented in the system by placing the appropriate card code number in column 1, the accession number in columns 2 through 9, the letter "M" in column 10, the user code in column 70, and the classification symbol in column 80. The fields to be left unmodified remain blank; the correct data are put in the field to be modified. To erase the content of a whole field, five "B"s are put into the first five columns of the appropriate card field and the modification continued as usual. It should be remembered that accession numbers cannot be modified. To correct such an error, the use of the deletion feature is necessary, with subsequent insertion of the corrected accession number.

Deletion Rules

This computer command serves to remove unwanted or erroneous records from the computer file. A valid delete instruction removes the complete item permanently from the file. To delete an item, the first step is to inform the clerk of such an intention. This must be done because the original data decks which instructed the computer memory are kept in the clerk's custody. The clerk removes the deck to be deleted from the active card repository and places it in the inactive section (destroys it if it held erroneous information). Then, and only then, does the clerk or the user write a delete card for the computer. This card must carry an 8 in column 1, the accession number of the item in columns 2 through 9, a "D" in column 10, the user code in column 70, and the appropriate classification in column 80. Only this single card is necessary to perform the delete operation.

Subject Indicators

Subject indicators are code words or phrases which convey meaning about the document or person listed. The computer itself does not recognize any rank structure between indicators other than alphanumeric succession independent of the meaning of the indicator(s). The indicators, when they are not the proper names of individuals (as in the case of listing the author of a document), are properly classified as descriptors of the content of the document. This implies that the classification of the item will be affected by the indicators listed for it. That is the reason for insisting that column 80 must carry one of the specified code letters.

Sufficient space for ten 25-character subject indicators is provided for each item to be listed. More indicators are available by listing the same item twice, or many times, with successive numbers appearing in columns 8 and 9 of the card decks. When such an expansion of the indicator's capability is necessary, the action should be indicated by noting in the title space "CONTINUED FROM ACCESSION NUMBER XYZ" or something similarly appropriate. In general, the 10 spaces are sufficient to provide a reasonably detailed description of the content.

Authors are listed, last name first, before any other descriptors. Experience with the retrieval system indicates that each author should be granted a separate space. Hence, all authors of one item are listed, last name first, in alphabetical order, one space per author. Then the other descriptors follow.

A descriptor may contain one or several words. The authority file, which lists all subject indicators used in the computer file at the date of issue and the frequency of their occurrence, should guide the user in his selection of terms and spelling. The descriptor should always be chosen with the capabilities of the retrieval system in mind. That implies the use of one word per field, the second word using a separate field and thereby fulfilling its function as a modifier. For instance, "DEFENSE" and "CONTRACTORS" should be used instead of "DEFENSE CONTRACTORS." Then, in retrieval, if the user calls for "DEFENSE" only, he receives all information of all items pertaining to the general subject. Otherwise he will have to institute a large number of retrieval operations with no assurance that he will get all the information known to exist. Writing should be started in the furthest left-hand column of the field.

Location Code

The location code is used to assist the user in obtaining a desired document. There are no limitations except space and propriety in the use of the location field. Columns 71 through 79 of cards 5 through 9 are used.

If the original document has not been retained, but a partial or complete copy has been made and retained, then a note to this effect is appropriate and

the word "COPY" appears in columns 71 through 74 of card 5. The copy of
this item may be filed in the main file, which is then noted by inserting the word
"FILE" in columns 75 through 79 of card 5.

User Code

The user code in column 70 identifies the library system in which the in-
formation is to be stored. Any single alphanumeric symbol can be used to
indicate a particular library system and its "owner."

Note that the computer will reject any information which fails to carry the
proper user code in every card, as well as refuse to enter a card set which
does not carry the address (code) required by the library system then being
worked on.

Classification Codes

Input, output, and storage of this program and any of its results or data
must conform to and be handled in accordance with the Department of the Navy
Security Manual for Classified Information, OPNAV Instruction 5510.1B, of
1 July 1963, and any subsequent additions or modifications.

Column 80 is used to ensure that the classification of information entered
on the library log decks has been carefully considered. A card on which a
"nonapproved" character appears in column 80 or on which the column is blank
will cause the computer to reject the whole entry in the processing cycle. This
means that the appropriate one of the 11 approved code symbols must appear on
every card of a library deck. The mixing of symbols in a single entry is not
permissible, for security reasons.

The following symbols must be used. Additions or subtractions are possi-
ble but require changes in computer programming.

```
UNCLASSIFIED MATERIAL. . . . . . . . U
PERSONAL CONTACTS OR EXPERTS . . P
"FOR INTERNAL USE ONLY". . . . . . D
CONFIDENTIAL MATERIAL . . . . . . C
SECRET MATERIAL. . . . . . . . . S
TOP SECRET MATERIAL . . . . . . T
(AEC) RESTRICTED MATERIAL . . . . . A
SAR UNCLASSIFIED MATERIAL . . . . W
SAR CONFIDENTIAL MATERIAL . . . . X
SAR SECRET MATERIAL. . . . . . . . Y
SAR TOP SECRET MATERIAL . . . . . Z
```

Classification code takes precedence over all others.

It is the responsibility of the user of the program to decide which code designation should be used with a specific library entry. This implies that only essential information is included in the entry. This does not imply, however, that essential information of potential interest to other users should be excluded because it slows the retrieval process for a few hours until the proper type of preclassified paper can be supplied to the computer. In most cases, the fact that the computer notifies the requester that some of his information is withheld for security classification reasons may be sufficient to lead to the location of the information via the subject file.

Rules Applicable for All Preparations

Every log card intended for use, even if it contains only a letter or two of information, must have the required notations in columns 1 through 10 as explained previously. Whichever card or space is not needed or used must be left blank on the sheet. Lines should not be drawn through unused spaces, as this would confuse the card puncher and impede efficiency. Columns 62 through 69 and 71 through 79 are blank on card codes 0 through 4. Column 70 must contain the user code and column 80 the appropriate classification code on every card used in the entry. If either is missing or in error, the computer refuses the entry.

INFORMATION RETRIEVAL

The use of the system can be considered to be divided into two problems. The first problem (discussed in the previous section) is that of inserting information into the system. This section will concentrate on the second problem, the retrieval methodology; i.e., the ways a user can obtain information from the system.

Library Listings

The computer produces aids which, as a generalization, have been called library listings. As long as the library system is relatively small (i.e., does not have many entries per subject indicator), the use of these aids may be entirely adequate for retrieval purposes.

The aids consist of two types of lists. One of the lists, the authority list, is relatively small and handy, so that revised copies can be issued to the members of the organization at frequent intervals. The up-to-date authority list can then be used to find the number of items stored in the program which pertain to some specific subject or interest. If the number is small, the other type of listing, the library list, can be consulted for additional information.

The library listings contain three computer-produced, alphanumeric-ordered parts, one of which is ordered by the source, another by the subject

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indicator, and the third by the accession number. The lists quickly become large and unsuitable for constant transportation; therefore, they should be placed in the custody of the person charged with the upkeep of the library system, presumably the central control clerk, and be available for use in that location only. If the number of items listed under a specific subject indicator is relatively small, it is not hard to inspect the detailed descriptions of these items in the file and to select the most applicable information from them. When the number of possible sources of information reaches a level which the user considers excessive, he has the option of calling for a computer retrieval operation.

Retrieval Call

In calling for a computer retrieval operation, the form shown as figure 2 should be employed. Initially, the subject retrieval log should probably be filled out with the help of the central control clerk, who is the only person with sufficient knowledge of the demands made on the system to allocate a control number in columns 2 and 3. This number is essential for all retrieval operations and must contain numerals in both columns--blanks are insufficient. The control acts to separate the calls introduced to the computer at the same time, and therefore is not required to be handled in a special manner except when several items appear in succession within one computer operation.

SUBJECT RETRIEVAL LOG

☐ URGENT   CLASSIFICATION

BLANK	CONTROL	BLANK	SEQUENCE	BLANK	COUNT	SUBJECT INDICATOR	REQUESTER'S NAME	USER CODE
1	2 3	4 5	6	7 8	9	10 39	40 59	70

Figure 2. Sample Retrieval Form.

The retrieval system can select and list those items in the storage memory which contain one, two, or three subject indicators. This method allows the user to be fairly selective in his initial search for information and is the reason for the existence of the "SEQUENCE" and "COUNT" columns in the retrieval log.

Each row of the log represents one IBM card, and each card carries one, and only one, subject indicator. The count, column 9, indicates how many of the indicators are intended to be grouped together into one request. The count for any request must therefore be 1, 2, or 3—uniform on every card of the request. In contrast, the sequence, column 6, refers to the order in which the subject indicators applicable to an individual request (and hence count) are arranged. The numbers in this column are therefore arranged in order, from a minimum of 1 to a maximum of 3.

The central control clerk will probably call for the services of the electronic accounting machine (EAM) operator to punch the retrieval log cards. The clerk's function is to make certain that format is maintained and control numbers do not conflict. In order to facilitate distribution of the requested material, the computer readout is arranged to furnish successive requests by the same user continuously, but starts a new page when another requester's name appears.

The most important item in a retrieval request is the subject indicator. Here, the authority file is of inestimable value. It is important to remember that, whatever the proper dictionary spelling of a word might be, the only word spelling the computer understands is the one it is familiar with. This means that subject indicators must be spelled in exactly the same way they appear in the latest authority file. Errors in spelling can be corrected, but that does not affect the immediate retrieval operation. The order (i.e., the sequence) in which a subject appears in a multisubject retrieval request is relatively unimportant while the file is small. However, as the amount of stored information increases with time, the subject should be ordered in inverse order from the number of items listed for the subject. This would tend to conserve computer time.

A user calling for a retrieval effort should also check the synonyms and antonyms of the subject he wishes to search for. Language for no two individuals is identical, of course, and there are many contributors to this information system.

CONCLUSIONS

The computer-aided library system described in this report appears to offer to relatively small scientific groups a feasible and time-saving capability for storing, referencing, and retrieving research material.

DOCUMENT CONTROL DATA · R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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5. AUTHOR(S) (First name, middle initial, last name)

Eric Neuron

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d.		

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Naval Air Systems Command

13. ABSTRACT

The problem of obtaining intelligence (i.e., information) in a timely fashion is only exceeded by the problem of how to reference, or store, that portion of the information which is of lasting interest or use. The referencing or storing methods must be designed to allow almost instantaneous retrieval of the key data leading to the desired information or the recovery of the information directly. A secondary, but frequently desirable, feature is the ability to determine quickly the kinds of information available as well as the quantity of items of each kind.

A computer-aided system has been devised which appears to be able to satisfy such referencing and storing needs for an organization of roughly 5 to 50 specialists. This report is intended to introduce the reader to the system and serve as a guide in the efficient use of its potentialities.

DD FORM 1473 (PAGE 1)

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computerized library system						
Data storage						
Data referencing						
Data retrieval						

DD FORM 1473 (BACK)
(PAGE 2)

SUPPLEMENTARY

INFORMATION

NOTICES OF CHANGES IN CLASSIFICATION, DISTRIBUTION AND AVAILABILITY

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